NIRCam Wisp Templates

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1 Introduction

During the acquisition of NIRCam flat field images using the zodiacal light background, two types of stray light were noticed. One are the "claws", which are caused by light from very bright stars ($K \lesssim 2$) that hits the NIRCam short wavelength channel spacers coming through the Aft Optics Subsystem. This can be mitigated by removing these stars from the optical path to the NIRCam spacers by small changes in the telescope orientation. "Wisps" are another type of contamination due to stray light reflected by the secondary mirror support system that shows fairly stable behaviour though not necessarily present in all images with significant S/N. During the commissioning activities the IDT+IDS teams found out that this contamination can be subtracted out prior to the production of the calibrated images.

2 Data and Procedure

The data used to construct the wisp templates come from the NIRCam Commissioning Activity *NRC-10* for proposal 1063 (PI: B. Sunnquist). The Level 1a images were copied from MAST and processed using the *NCDHAS* reduction code developed by the UofA instrument team (Misselt 2007; 2022) using ground-based calibration files. The *rate* files (in DN/s) produced by *NCDHAS* are identical to the level 2 products coming from STScI DMS stage 1. The reduction included the removal removing instrumental signatures (IPC, bias, linearity correction) and cosmic-ray removal.

All *rate* files were visually inspected to remove images containing claws. The remaining images were stacked (by filter and detector) using the outlier-resistant bi-weight average (Beers et al. 1990, AJ, 100,32) and the median-sky image calculated from the division of the stacked image by the corresponding pixel-flat image. The last steps in preparing the wisp templates are calculating the average sky background counts of the median sky (again using the bi-weight estimator) and subtracting the latter from the median-sky image.

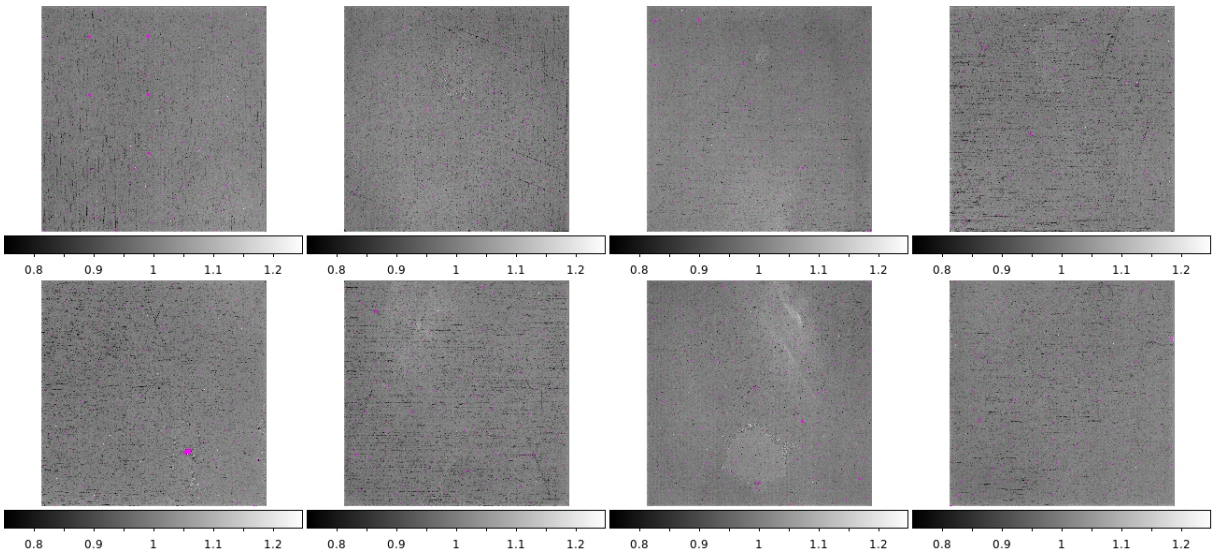

Figure 1: Example of wisps measured during JWST commissioning in filter F150W2 in a mosaic with all short wave detectors. The top row of detectors is [A2, A4, B3, B1], bottom row [A1, A3, B4, B2]. The wisps are most intense in detectors A3, B3 and B4.

3 Results

Wisps are detected at a significant level for three detectors - A3 on module A and B3 and B4 on Module B and are most prominent in the F150W2 and F200W filters. Figures 1 and 2 show mosaics of all short wavelength detectors for three filters (F150W2 in Figure 1, F200W in Figure 2 and F210M in Figure 3). Two examples of wisp removal are shown in Figures 4 (for F150W2) and 5 for(F200W) where the left panel shows the rate file the right panel the wisp-subtracted image.

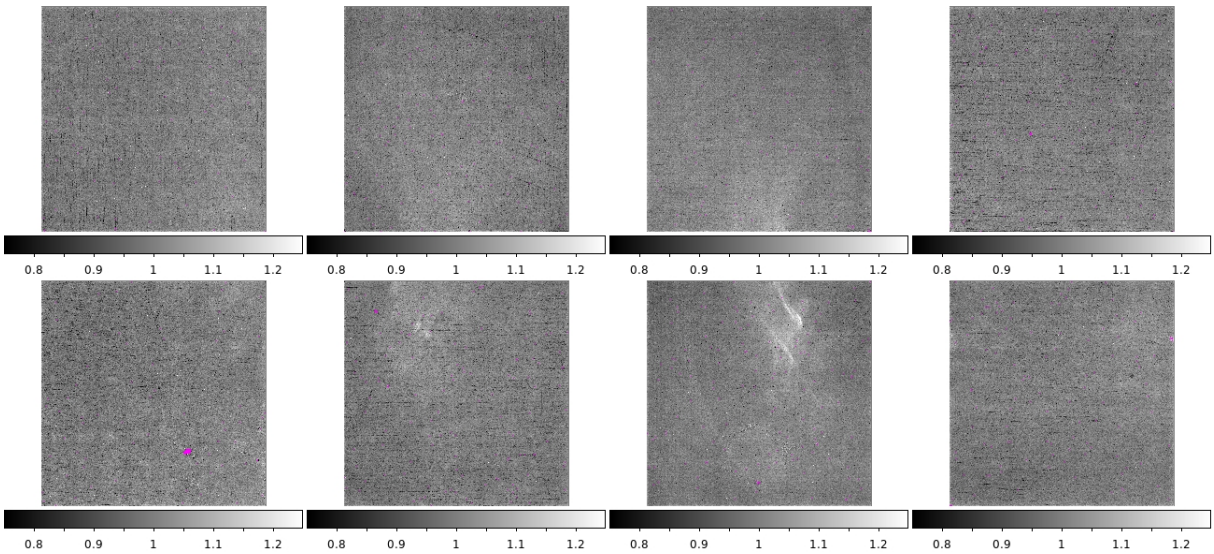

Figure 2: Example of wisps observed in the F200W filter; as in the previous figure, the top row of detectors is [A2, A4, B3, B1] and the bottom row [A1, A3, B4, B2]

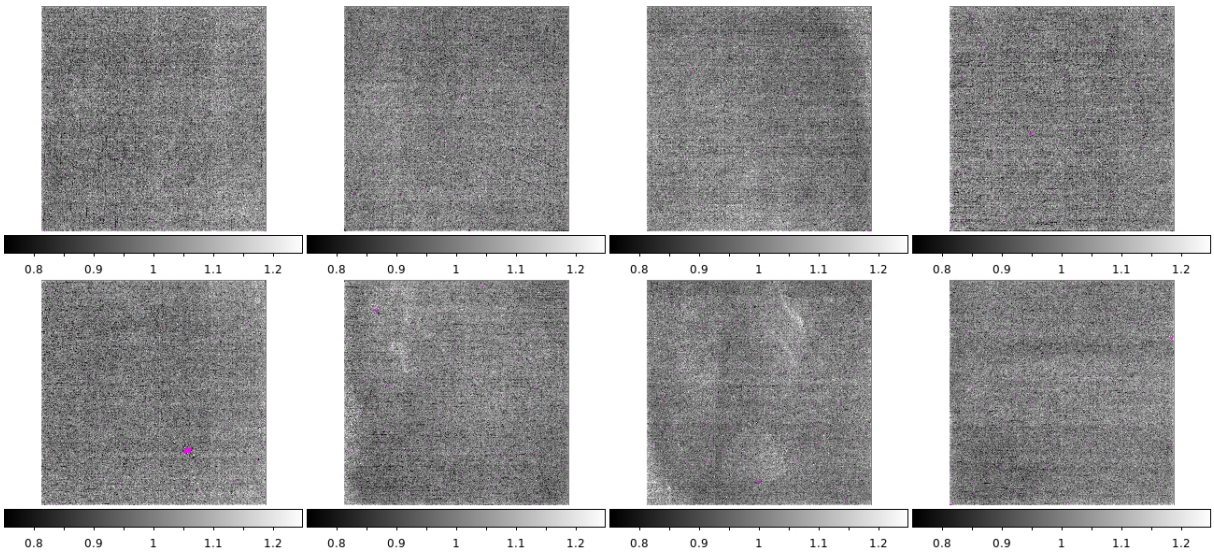

Figure 3: Example of wisps observed in F210M, using the same detector arrangement of the previous figures.

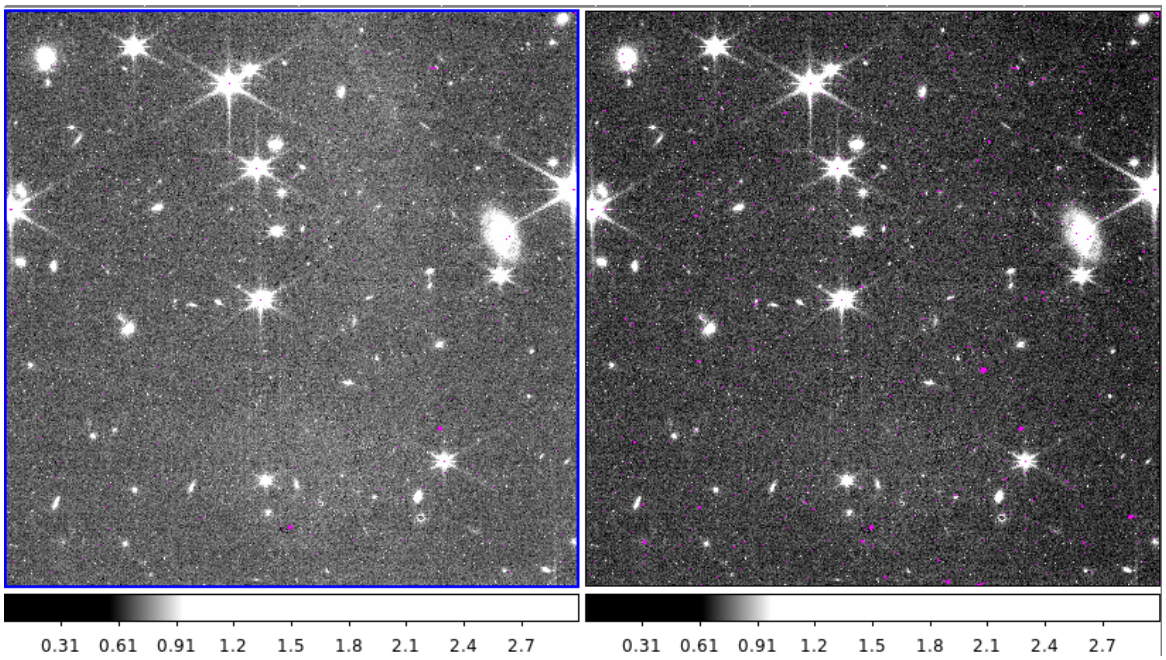

Figure 4: Image before (left panel) and after subtracting the wisp template. This is commissioning observation jw01063117002_02101_00001_nrcb4 using the F150W2 filter. In both panels the scale and limits for both panels were locked to be identical. The magenta points flag pixels presenting "NaN" values, which are not used in the data processing.

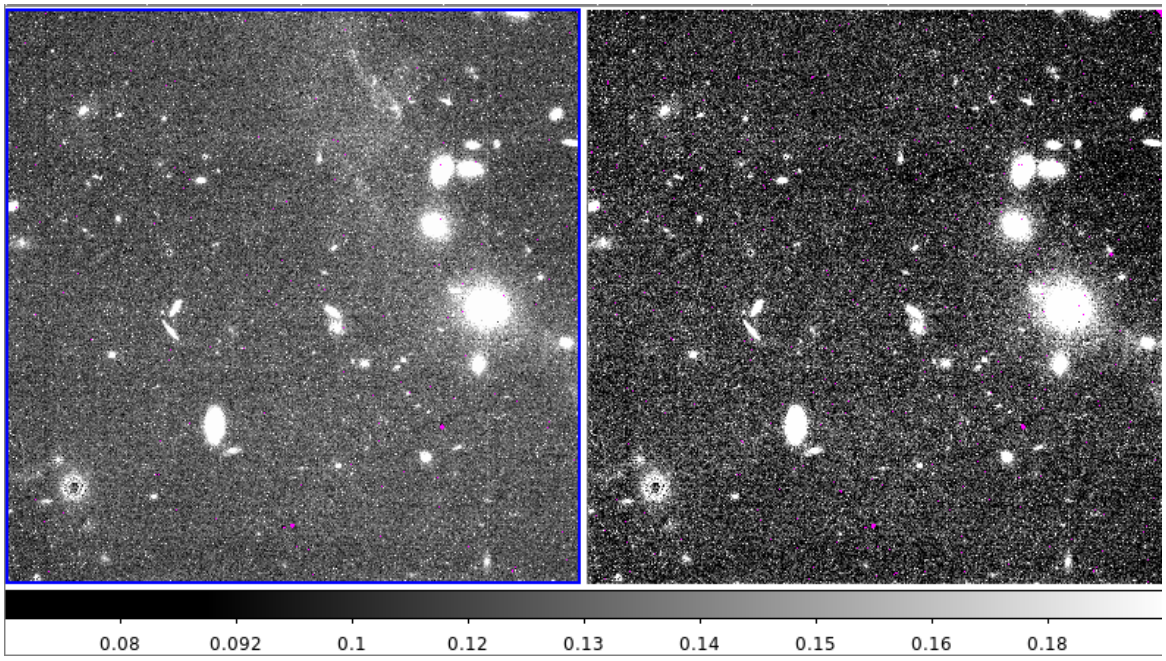

Figure 5: Image before (left panel) and after (right panel) subtracting the wisp template. This is commissioning observation jw01063001003_02101_00001 using the F200W filter. As in the previous figure the scale and limits for both panels were locked to be identical.